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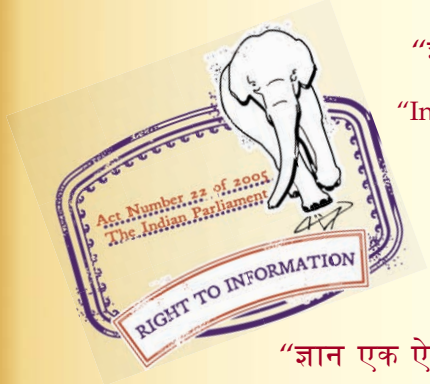
IS 10087 (1981): Code of practice for handling of electrostatic sensitive devices [LITD 5: Semiconductor and Other Electronic Components and Devices]

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"Knowledge is such a treasure which cannot be stolen"

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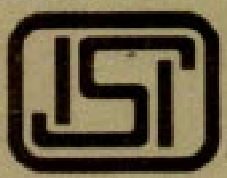
IS : 10087 - 1981
( Reaffirmed 2006 )

# *Indian Standard*

# CODE OF PRACTICE FOR HANDLING OF ELECTROSTATIC SENSITIVE DEVICES

UDC 621·3·049·77·004·2 : 006·76





**INDIAN STANDARDS INSTITUTION**
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4

*November* 1982

# *Indian Standard*

# CODE OF PRACTICE FOR HANDLING OF ELECTROSTATIC SENSITIVE DEVICES

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# *Indian Standard*

# CODE OF PRACTICE FOR HANDLING OF ELECTROSTATIC SENSITIVE DEVICES

## 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 23 November 1981, after the draft finalized by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

**0.2** Modern technology has produced devices, for instance, metal oxide silicon devices, with dielectric layers of the order of 0·1 micron thick. The thinness of such layers often results in a value of gate breakdown voltage of 70 to 100 volts. Static electricity of many thousands of volts can, however, be generated in many everyday ways. The factory operator can generate static electricity by moving around on a chair, brushing against benches or walls, or simply walking across the floor. Items handed from one person to another, or being wrapped or unwrapped, can acquire a static charge. Air conditioning systems, and the spraying of synthetic materials, such as cleaning liquids or conformal coatings, can also result in generation of static charge. Clothing of man-made fibres is specially prone to generate static charge. This static electricity is usually not even noticed by the operator, but its transfer can nevertheless be sufficient to destroy a device.

**0.3** Some devices are provided with inbuilt protection against static charge, but it is not necessarily sufficient under all circumstances, and the only true safeguard is to prevent the build-up of charge on the device terminals. This code of practice outlines the methods by which it may be done.

**0.4** While preparing this standard, assistance has been derived from the following documents.

a) IEC Doc: 47(C.O.) 701: 'Handling precautions for static sensitive semiconductor devices' issued by the International Electrotechnical Commission.

b) BS 78/22265 'Draft standard code of practice for the handling of static sensitive devices' issued by the British Standards Institution, United Kingdom.

## 1. SCOPE

**1.1** This code of practice gives the precautions which apply to the storage, transport, handling and testing of all kinds of static-sensitive devices, circuits and assemblies.

## 2. TERMINOLOGY

**2.1 Electrostatic-Sensitive Device ( ESD )** — A device which can be damaged as the result of the transfer of static electricity via its terminals.

NOTE — ESDs include MOS ( Metal Oxide Silicon ) devices, and certain other low-leakage devices.

**2.2 Special Handling Area ( SHA )** — A working area, organized to the requirements of **5** of this code of practice, where ESDs may be handled without damaging them by discharge of static charge.

**2.3 Conductive** — For the purpose of this code of practice only, conductive is defined as having a surface electrical conductivity of $>0{\cdot}01$ mm per square ( surface resistivity $<100$ k$\Omega$ per square ).

NOTE — This definition permits the use of metal and/or certain types of foam. Metal is robust and readily available, but may physically damage dropped devices, and it will effect any discharge more rapidly than foam.

**2.4 Ground** — For the purpose of this code of practice only, ground is defined as either:

a) earth potential as imposed by an earth spike which is completely independent of the earth conductors of the mains electrical supply, or

b) a uniform potential other than earth potential.

NOTE — Earth potential is most often convenient, but is not mandatory. In aircraft or boats, or at the top of tall buildings, it may be more convenient to accept alternative (b). Extra care should be taken when transferring devices between areas at different potentials.

**2.5 Bonding** — For the purpose of this code of practice only, bonding is defined as interconnections of various devices, tools, equipment, surfaces, etc, so that the potential of the device and of everything with which it is likely to come into contact will be the same.

**2.6 Package** — Box in which the electrostatic-sensitive device is externally packed.

NOTE — In this code of practice, package is not intended to refer to the plastic encapsulation of the device, or its hermetically sealed can.

## 3. EQUIPMENT DESIGN CONSIDERATIONS

**3.1 Identification** — The equipment designer, while choosing an electrostatic-sensitive device, should take care that its nature is notified to all other associated agencies involved in procurement, layout, use, etc. He should, where appropriate, annotate drawings and parts lists with 'ESD', and where appropriate give instructions on the sequence of assembly. Particular note should be made of protective components, the removal of which would leave the ESD unprotected.

**3.2 Layouts** — These should be so designed that inadvertent touching of high-impedance points is avoided, and the use of dummy shorting connections facilitated. For instance, any printed wiring tracks linked to the input pins of ESDs should be placed away from the board edges to minimize the risk of handling contact when the boards are being assembled or fitted to equipment.

**3.3 Warning Notices** — The design of the equipment should allow for the provision of warning notices, especially for the information of maintenance and servicing personnel who may have no connection with the original equipment maker. In this respect, servicing and instruction manuals should deal adequately with ESD treatment.

**3.4 Protection** — Termination resistances or other electrical protection should be fitted as close to the ESD as possible.

**3.5 Gates** — All unused gate inputs should be linked to the appropriate voltages supply rail, depending on the function, so as to reduce the risk of burnout across an unconnected gate. MOS gates in particular should not be left with floating inputs, since, unlike TTL, MOS gates may shift at random from one state to another due to small static charges.

**3.6 Capacitance** — Excessive capacitive loads, for example, those resulting from layout or attached cables, should be avoided when using ESDs.

**3.7 External Protection** — In so far as the required performance of the circuit permits, any internal device protection can be supplemented by external components specified by the designer, for example, bleed resistors or suitable voltage limiters.

**3.8 Power Supplies** — Circuits containing ESDs should incorporate protection to prevent transients on mains supplies greater than 100 volts peak. Local power lines should be protected, so that transients above 20 microjoules are inhibited.

## 4. MARKETING, PACKAGING AND TRANSPORTATION

**4.1 Manufacturer's Literature** — The manufacturer's catalogue and individual device data sheets should clearly indicate that the device in question is sensitive to electrostatic charge.

**4.2 Marking of the Device** — Suitable markings shall be made on the devices to declare its sensitive nature.

**4.3 Packaging** — Each device should be adequately packed to protect it mechanically, and to prevent the build-up of static electricity on individual leads. The latter may be achieved by, for example,

a) the interconnection of all the leads on each device, for instance, by wire, spring clip, metal foil or metal eyelet, or

b) by mounting the device on, or surrounding it by conductive material, or

c) by the use of other materials having anti-static properties.

**4.4 Package Marking** — A warning label and adequate instructions must be encountered before it is possible to expose the device. The warning label should preferably seal the package.

**4.5 Distribution** — The device manufacturer should ensure that every distributor or agent complies with this code of practice and despatch notes should indicate clearly that the device is electrostatic-sensitive.

**4.6 Transportation** — No special precautions are required provided the package ( *see* **4.3** ) remains intact.

## 5. SPECIAL HANDLING AREA ( SHA )

**5.0 General** — Individual ESDs should never be directly handled, except in a special handling area ( SHA ). There are two types of handling areas. The first establishes a uniform potential to all devices within the area by means of electrically conductive connections. The second relies on electrically conductive ( ionized or humid ) air. To establish an SHA, one or other of the following should, therefore, be followed. A special handling area arrangement is shown in Fig. 1 as typical workstation layout.

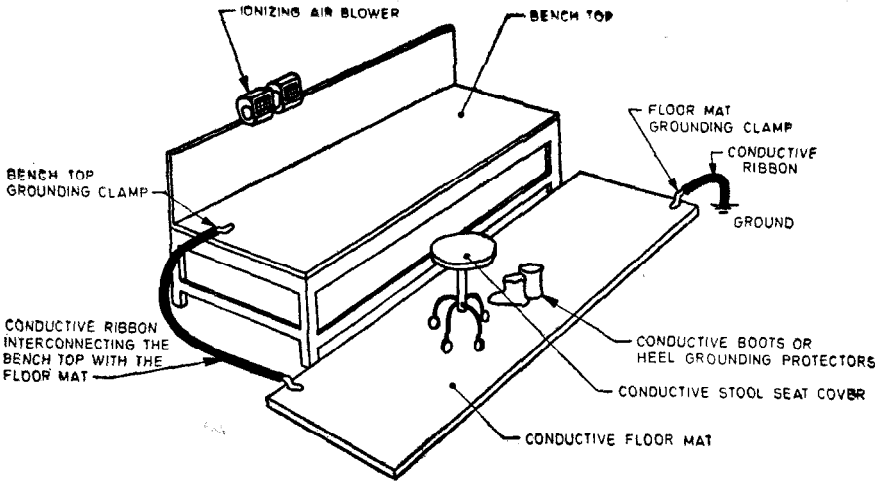


FIG. 1 TYPICAL WORKSTATION LAYOUT

## 5.1 Type 1

### 5.1.1 *Organisation*

**5.1.1.1** *Working surfaces* — The working surface should be conductive and grounded, and should be of a size to accommodate not only the work in hand but also all tools and input and output trays.

**5.1.1.2** *Seating* — Chairs and tools should each have a conductive cover to the seat and should be bonded.

**5.1.1.3** *Containers* — Any container which forms part of the SHA permanent equipment should be conductive and bonded. For transit and storage, containers may have to be stocked at the SHA ( *see* **6.4.3.** )

**5.1.1.4** *Skin contacts* — A quick-release skin contact ( for example, wrist strap ) should be provided for each operator and should have a leakage resistance to ground of between 100 k Ω and 1 M Ω.

**5.1.1.5** *Floor surfaces* — The floor surface and any foot-rest should be conductive and bonded.

**5.1.1.6** *Electrical supplies* — Any mains electrical supply to the SHA should be fed through a suitable isolating transformer with an earth leakage trip device.

**5.1.1.7** *Bonding* — Any mains-connected apparatus ( including soldering irons ) should be bonded only as described in **2.5**.

**5.1.1.8** *Checks on bonding* — Bonding connections and any earth trip should be checked at least once a month and the check certified.

**5.1.1.9** *Identification* — The area should be identified by a sign visible clearly in the locale.

**5.1.1.10** *Local instructions* — A copy of this complete code of practice or an amplified local instruction, preferably with a layman's guide to static change, where personnel are likely to be non-technical, should be available at the SHA.

**5.1.1.11** *Adjacent electrical machinery* — When locating an SHA, consideration should be given to the proximity possibly concealed of machines such as RF generators and welding machines whose fields may adversely affect SHA operation.

**5.1.2** *Operation*

**5.1.2.1** *Unpacking* — Most SSDs are supplied packed in conductive foam or with their terminals otherwise conductively connected. They should be removed from this protection only immediately prior to assembly.

**5.1.2.2** *Removal from packing* — Before removing a device from its protective packing, the operator should simultaneously touch the bonded conductive bench top with one hand ( unless he is wearing a conductive and ground wrist strap ) and the conductive packing with the other hand in order to discharge any potential difference. Before placing the device in a new packing, the operator should likewise simultaneously touch the new packing and the bench top.

**5.1.2.3** *Precautions during handling*

a) Handlers of ESDs should cultivate the habit of frequently touching the conductive bench top to discharge any accumulation of static charge. The routine of constantly bonding the assembly, the ESD packing carrier, the device itself and the handler should be practised whenever ESDs are being used.

b) If it should become necessary to lay the device on the workbench without its terminals being otherwise protectively shorted, it should be so placed that its terminals are in contact with the conductive bonded bench top till the moment of assembly.

c) In unpacking the device, the terminals should not be allowed to come into contact with any plastic outer container.

d) A static-sensitive device should never be handled by its leads.

e) ESDs should never be mixed with other devices in kit marshalling and should always be kept separate.

**5.1.2.4** *Electrical testing* — For electrical testing, insertion into a test socket should precede removal of any shorting wire or foam. If the presence of the latter blocks insertion, an intermediate stage of more compact lead shorting may be employed. On completion of testing, the original shorting wire or foam should be replaced before unplugging the device. At all times, therefore, the device should be either protectively shorted, or in circuit.

**5.1.3** *Operatives* — Personnel handling ESDs should wear outer clothing which will not generate a static charge. Cotton or linen is preferred; wool frequently contains man-made fibres as well, and should, therefore, be avoided. The use of fibre-rejuvenators in cleaning such garments is deprecated. Nylon or dust-coats should not be worn. Gloves, finger-stalls or coats, other than of cotton or conductive plastic, should not be worn.

## 5.2 Type 2

**5.2.1** *Electrically Conductive Air* — In this type of SHA, the air surrounding devices or assembly work is deliberately made and maintained electrically conducting, either by ionization or by controlled humidification.

**5.2.2** *Ionization* — Ionized air ( for example, from a corona discharge ) is provided to prevent or eliminate any random charges on the devices or assemblies during those periods when other protection is intentionally removed.

**5.2.2.1** The means employed to produce ionization will depend on local circumstances but attention is particularly drawn to the safety aspects and need for operator protection.

**5.2.2.2** The direction of airflow from the ionization generator should preferably be away from the operator across the work area.

**5.2.3** *Humidification* — By suitable use of humidifiers, a constant flow of damp air at relative humidity between 60 and 80 percent is provided across the work area.

It is essential that shorting arrangements are restored to the devices or assemblies on completion of work in the SHA.

NOTE — This method is not suitable where unsealed components are used.

## 6. RECEIPT AND STORAGE

**6.0 General** — Handling of 'transit wrapped' and 'unpacked' electrostatic-sensitive devices is more likely to occur in the stores area than anywhere else in the chain of equipment manufacture, testing and use. Expertise in this area is frequently not technical; supervision and application of these procedures is, therefore, more important.

All stores personnel should become fully acquainted with the possibility of the danger to devices ( NOT to themselves ) resulting from neglect of these procedures, and the costs incurred in their re-ordering, delivery time and re-entry procedures, quite apart from their item cost.

**6.1 Fittings** — All metal racks in stores and their associated trays and boxes ( whether anti-static treated plastic or metal ) used for storage, kit marshalling and transport to assembly points should, at rest, be electrically bonded. ( In this case only, it is permissible to connect to the earth terminal of the electricity supply. )

Storage of ESDs should wherever possible be in the packing as received from the device manufacturer. If this is not possible, other containers as defined in **6.4.3** may be used.

The maximum possible use should be made of adhesive warning labels. These should warn against mishandling of static-sensitive devices and assemblies using them whether in equipment manufacture, testing, or servicing.

**6.2 Recognition** — Methods of identifying electrostatic-sensitive devices, particularly by different suppliers across the world, vary. Each user company will need to recognize such items and identify them in assembled sub-unit conditions and possibly even as individual components.

**6.2.1** The supplier may decide to:

a) apply in-house identification at customer's request,

b) employ standard symbology or labelling which should be instantly recognizable by all customers,

c) apply no special visual identification but simply rely on the device protection being recognized.

Arrangements should, therefore, be made by the user company to ensure adequate recognition at the 'Goods-Inwards' stage.

**6.2.2** Warning labels or marking required to be added, by in-house instruction to packaging, containers, or sub-units containing static-sensitive devices, should be applied at the earliest point possible in this recognition process. It is desirable that the label should form a seal.

**6.3 Goods Inwards Inspection** — Assuming adequate transit packing and safe transport to the customer, goods inwards is the first point of physical contact between the purchasing company and the goods as despatched by the supplier. Accordingly, the prime protective action is 'recognition' ( *see* **6.2** ).

**6.3.1** *Action on Receipt* — Any parcel, package, etc, recognised from known indications as containing static-sensitive devices should be taken exactly as wrapped when recognized to a nominated SHA for handling in an approved manner. In case of doubt, reference should be made to a competent authority before unpacking.

**6.3.2** *Visual Checking Against Order* — Verification of quantity supplied, and visual checking of items ( by reference to marking, advice notes and the goods inwards copy of the customer's order ), should be carried out at an SHA. While at the SHA, the quantity and type should be marked on the outside of any non-transparent container.

**6.3.3** *Electrical Tests* — Any electrical test required at goods inwards should be carried out at an SHA.

**6.4 Transport ( Handling or Movement )** — Movement within a user factory area, for example, for unpacking and checking, quality verification, storage and kit marshalling, is a user responsibility and the precautions indicated should be taken.

**6.4.1** *Devices in Transit* — Where possible, devices should be retained in their original transit containers after external wrapping has been removed.

**6.4.2** *Division of Quantities* — If, for contents separation, kit marshalling, or other reasons the original container, possibly with device leads shorted by conductive foam, needs to be discarded or supplemented, all operations should be carried out at an SHA.

**6.4.3** *Containers* — Approved containers shall be used for storage and transit, for example:

a) The device manufacturer's original conductive container. Attention should be paid to the effective life-time of the materials, especially in respect of the susceptibility to abrasion of certain anti-static treatments when applied superficially as also possible corrosion of metal parts.

b) A rigid metal container.

c) A container fully lined with conductive foam.

d) A conductive plastic bag which completely contains and surrounds the ESD or the assembly incorporating it. For this purpose, conductive plastic film or foam not less than 0·1 mm thick is convenient. Film can be formed into an immediate wrap or formed into bags that are sealable for longer term storage. Metal, for example, aluminium foil, is an effective short-term expedient, but is liable to tearing and puncturing.

**6.4.4** *Dropped Devices* — If a device has been dropped, the insulated body or metal should be grasped with a previously electrically grounded hand or tool.

## 7. PRECAUTIONS TO BE TAKEN DURING ASSEMBLY

### 7.0 General

**7.0.1** The incorporation of electrostatic-sensitive devices into an assembly should take place in a special handling area ( *see* **5** ).

**7.0.2** The including of ESDs should be the last operation of an assembly process.

**7.0.3** Packages containing ESDs should be placed on a special bench, and ESDs should only be removed individually when required for assembly.

**7.0.4** Tools and equipment which are not bonded should always be touched to the bonded bench top before use, and returned there afterwards.

### 7.1 Assembly Process

**7.1.1** Immediately prior to assembly, the conductors to which ESDs are to be attached should be shorted and bonded.

**7.1.2** Except where it can be shown that no risk of static charge generation can exist, the ESD terminals should all be kept shorted during assembly, for example, by spiral spring, clip, or conducting tape. If it is necessary to alter the means of shorting, the new should whenever possible be attached before removing the old.

**7.1.3** Once the ESDs are securely in circuit, their individual shorting connections may be replaced with unit-shorting ( dummy ) connectors applied to the terminals of the circuit assembly. The unit connectors should remain in position until final insertion of the assembly into the using unit, with possible temporary removal only for testing. The dummy connectors

should be returned to stores from the final equipment assembly point, except for equipment spares items, which should be despatched with an explanatory note with the connectors still in position.

NOTE — If layout and circuit design have produced an intrinsically electrostatic-safe assembly, the requirements of this paragraph may be waived.

**7.1.4** Uncompleted assemblies shall be stored in an appropriate container (*see* **6.4.3**).

### 7.2 Additional Precautions

**7.2.1** Printed board conductors should not be touched.

**7.2.2** Automatic machines should be fitted with electrostatic charge eliminators.

**7.2.3** Equipment incorporating ESDs should not be subjected to high electrostatic charge.

**7.2.4** For the testing of completed assemblies, *see* **8**.

## 8. ELECTRICAL TESTING

**8.1 Inspection and Testing** — Inspection and testing, whether of device, unit, assembly, or equipment, and any adjustments found necessary, should be carried out under SHA conditions. Reference should be made to **5**, **6** and **7** of this code of practice.

### 8.2 Test Precautions

**8.2.1** Voltages for continuity testing in excess of 1·5V will require specific authorization. Tests should be carried out with a low-open-circuit-voltage transient-free tester, with a short-circuit current not greater than 10mA, since some built-in protective diodes cannot sustain a greater current. Care must be taken with the use of multi-range test meters, particularly of the latest digital type, for incoming inspection measurements, as some of these instruments can damage the more fragile microwave devices. Audible testers should never be used when ESDs are present.

**8.2.2** Voltages, other than ground potential, should not appear at the test socket until the device is fully inserted.

**8.2.3** The design of automatic test equipment should be such that high voltages do not appear at any of the socket terminations between the tests of the sequence.

**8.2.4** Unless specified otherwise, power supply voltages should be applied before signal inputs, and should be maintained until input signals have been removed.

**8.3 Functional Checks** — When functional checks are carried out at an SHA, it should be remembered that the bench top is conductive.

## 9. FIELD REPAIRS

**9.1 Use of SHA** — If the equipment is small enough, it should be transferred to an SHA.

**9.2 Assembly Removal Outside SHA** — Where transfer of the whole equipment to an SHA is not possible, an assembly may be removed without damage by utilizing the metallic mass of the equipment as ground ( *see* **2.4**), the operative discharging to the equipment any static charge which he may have accumulated, before touching the assembly. The removed assembly should then be placed in an approved container and taken to an SHA for any required examination. The discharge process should be repeated before replacing an assembly in the equipment.

**9.3 Replacement of Faulty ESDs** — Replacement of a possible faulty ESD should always be carried out at an SHA. Faulty devices should be placed in conductive containers, so that faults can be investigated without introducing additional damage.

**9.4 Field Repairs under Emergency Conditions** — In an emergency, and only where a properly setup SHA is not available, any large metallic mass, or aluminium kitchen foil, or even a damp cardboard box, may be used as a working surface. It should be noted that dry conditions, for example, desert or forest, are particularly hazardous as regards generation of static charge, and require special care.